SKELETON OF *LUVARUS IMPERIALIS*, RAFINESQUE.

(A FISH NEW TO THE WESTERN PACIFIC FAUNA).

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(Plates xlv., xlvi., and Fig. 22).

LUVARUS IMPERIALIS, *Rafinesque.*

Luvarus, known from the Mediterranean, the Atlantic (from Madeira northwards to the coast of Cornwall), and also off the Californian coast,[1] is now to be added to the Australian fauna.

On September 5th last, the Curator received information from Mr. J. A. Brodie, Chief Inspector of Fisheries for New South Wales, that a strange fish had been stranded at Bermagui. The communication was accompanied by a rough sketch, and the following particulars noted by Mr. Elias Laycock, one of the Fishery Inspectors:—"Length about six feet two inches, girth four feet eight inches, spread of tail two feet three inches, weight between two and three hundredweight, colour salmon and silver, flesh white."

Rough as was the sketch, it was so characteristic that we had no difficulty in recognising it as representing *Luvarus*. To have recorded the existence of this Atlantic form from the South Pacific on the evidence of a rough sketch would, under any circumstance, have been so unsatisfactory, that every effort was made to secure at least some portion of the original. Our best thanks are due to Mr. Brodie in this connection, for later in the month we received the skeleton, broken and incomplete, yet in sufficiently good condition to enable our articulator to prepare it for the Museum, and for me to add a little to our knowledge of this interesting form.

After this paper was written, we (on January 7th, 1902) received from Mr. Brodie further particulars: the information, contained in a letter from Inspector W. H. Newton, is as follows:—

"In the beginning of last August, Mr. Elias Laycock and his son, of Port Hacking, found a very large fish stranded on a beach at Bermagui, five hundred yards up the river, the fish being alive and in good condition, with the exception of one side fin, which had been broken. The colour of the fish, when alive, resembled that of the Nannygai (*Beryx affinis*, Günth.), and the flesh inside

[1] See page 297.

was very white and free from blood. It is supposed that the fish was in search of food, owing to the large quantity of 'Whale-food' (small shrimps) which was round the fish on the sand. The depth of water there was about four feet at high water and perfectly dry at low tide."

Our determination of the fish from the rough sketch of the outward form is rendered absolute by a comparison of the skeleton with the figure published by Günther under the synonym *Ausonia cuvieri*.[2] This figure, reproduced from a drawing by Rüppell, while apparently well representing the general form, indicates that the skull was very incomplete. Günther did not attempt any description of it, merely remarking:—"the configuration of the bones of the skull will be seen from the accompanying figure."

While the skull cannot be said to be perfect in our specimen, its condition warrants me in attempting to describe the principal features of such an interesting type.

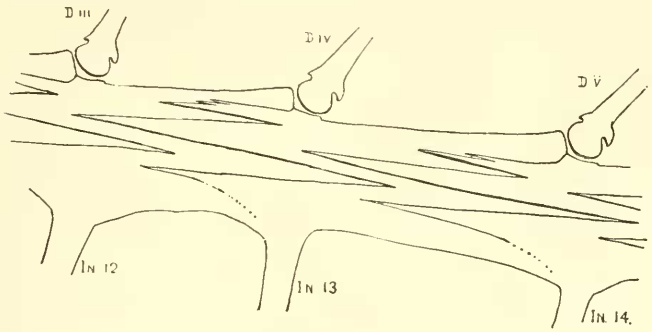

Fig. 22.

Owing to anchylosis in what is probably an old specimen, and also to fractures occasionally confusing the sutures, their exact limits cannot always be determined. I am not certain, for example, of the limits of the symplectic, mesopterygoid and metapterygoid bones.

A striking feature of the skeleton is presented by the union of the interneural spines into a complete bony arch, which extends from the union of the ethmoid and parietal bones backwards to the eighteenth vertebra; a similar arch is formed below by the union of the interhæmal spines, and extending from the pelvic girdle backwards also to the eighteenth vertebra. The union of the several interneural and interhæmal spines is effected by a very complex suture (Fig. 22). Each segment sends forward three long splints, and a similar number backwards; it is so encroached

[2] Günther—Proc. Zool. Soc., 1866, p. 337.

upon by splints from the adjoining segments that an illustration can only accurately convey the arrangement.

The accompanying figure shows the thirteenth interneural element, and portions of those in front and behind it. The dorsal spine, apparently corresponding to the thirteenth interneural, is the fourth ; but the twelfth interneural also participates in forming the articular socket. All the other spines, and those of the anal also, similarly arise from two elements.

The portions of the dorsal and ventral arches in front of their respective spines have their elements rigidly joined, while those posteriorly are loosely articulated ; the same arrangement is seen in the vertebræ, so that lateral motion for purposes of locomotion is permitted; and in this connection it is to be noticed that the posterior portions of both the arches and the vertebræ are much the stronger.

The upper and lower arches together form a very regular figure, divided longitudinally by the vertebral column, which, however, lies a little nearer to the dorsal than to the ventral arch. After its union with the skull in front, the upper arch gives off a strong flattened spine, which passing downwards and forwards reaches the occipital bone. The first neural spine is similarly flattened, and strong, and arises apparently from the occipital region of the skull, this portion should therefore be regarded as the first vertebra, though but for the spine its nature would be overlooked; it is anchylosed to the second vertebra by a thin plate of bone above, which encloses the second neural spine, this is thin and styliform ; the second interneural spine is anchylosed to the plate of bone. The neural canal is closed above as far as the middle of the third vertebra, thence is an open canal formed by a thin ridge, the neural process, on each side.

The first hæmal and anterior interhæmals being imperfect, these parts have been restored from Günther's figure, I cannot therefore describe their arrangement. The first hæmal spine arises from the eleventh vertebra, but has a small bony support from the tenth. The ribs, seven in number on each side, commence on the the third vertebra, and are strong and sabrelike. The neurapophysis and hæmapophysis of the seventeenth vertebra, together with their spines, are directed forwards and broadly flattened to strengthen the attachment with the interneural and hæmal arches. These arches are vertically broadened posteriorly, and are received by modifications of the apophyses of the eighteenth vertebra. The nineteenth vertebra is short, circular in section, and the only one permitting rotation. The twentieth is square in section, produced posteriorly above and below to receive the next, which is similar in shape, and the first to actually support the base of the caudal rays. These segments are joined much as is the spliced handle of a cricket bat. The nineteenth to twenty-first form the peduncle.

Another vertebra intervenes between this and the hypural, making twenty-three in all. The caudal fin is short, but produced above and below into a powerful organ.

The first dorsal spine is situated above the neural of the tenth vertebra, and is preceded by a groove which recalls the condition described by Lowe.[3] The following spines, twelve in number, are weaker. The anal possesses fourteen spines, but owing to imperfections, as before remarked, their relationship to the interhæmals is not clear; there are generally two of the latter to each hæmal.

The skull has a peculiar aspect, produced largely by the low position of the orbit, it being much beneath the axis of the body; the small anterior mouth, the raised parietal crest, and the large opercular apparatus, are also noticeable features. The occipital is largely encroached upon by the first interneural and neural spines, the lower ends of which are apparently formed by union with an occipital crest. The parietals overlie the frontals and are deflected behind to join the upper limb of the post-temporal. The frontal is not so extensive as usual, and a large foramen occurs between it and the ethmoid. The interparietal crest arises partly from this bone. The connection of the pterotic with the post-temporal is not preserved in our specimen. Suborbital bones are not present, and are possibly not developed. The eye is strengthened by an osseous ring.

In the suspensorium, the hyomandibular is joined by suture with the metapterygoid the latter separated from the quadrate by the symplectic. The articular and dentary are both short. The dental margins of the premaxillary, vomer, palatine, and dentary are roughened, but teeth are not present.

The post-temporal is widely forked, and has a bony attachment to the skull. The suture between the clavicle and supraclavicle is very long. The post-clavicle is attached by ligament below to the hypocoracoid. The hypercoracoid has an oval foramen through its centre. Actinosts graduated, five in number, the uppermost anchylosed to the base of the first two pectoral rays.

The representative of the pelvic girdle is a weak bone, whose connection with the clavicle is destroyed. Anterior to the verticle of the base of the pectoral it expands laterally, leaving a foramen for the vent. It is continued as a narrow vertical plate to join the base of the first interhæmal spine. Anterior to the vent is the unpaired ventral fin, represented only by the spine, which is a lanceolate plate, articulated at its base, and forming an operculum for the vent.

The bones, on the accompanying plate of the skull, are numbered according to the list published by Starks,[4] "Synonomy of the Fish Skeleton." This excellent compilation supplies a distinct want,

[3] Lowe (Günther)—Cat. Fish. Brit. Mus., ii., 1860, p. 414.

[4] Starks—Proc. Wash. Acad. Sci., iii., 1901, pp. 507–539.

and a desirable uniformity would be secured by Ichthyologists adopting the nomenclature and numerals of the "Synonomy." I shall be pleased, if by setting the example, I have contributed to this end. Disagreement with the author's homologies might affect the names but not the numbers applied to the several elements.

The bones herein illustrated are as follows:—

1. Vomer
2. Ethmoid
3. Prefrontal
4. Frontal
5. Sphenotic
6. Parietal
7. Epiotic
8. Supraoccipital
9. Pterotic
13. Parasphenoid
17. Hyomandibular
18. Symplectic
19. Quadrate
21. Palatine
22. Mesopterygoid
23. Metapterygoid
24. Preopercle
25. Opercle
26. Subopercle
27. Interopercle
28. Articular
30. Dentary
31. Maxillary
32. Premaxillary
33. Ceratohyal
36. Basihyal
37. Glossohyal
38. Urohyal
53. Post-temporal
54. Supraclavicle
55. Clavicle
56. Postclavicle
57. Hypercoracoid
58. Hypocoracoid
60. Actinosts
61. Pectoral rays
62. Pelvic girdle
63. Ventral spine

Our specimen of *Luvarus* is probably the largest known; the type was five feet in length, subsequent examples smaller. The skeleton yields the following dimensions:—

	Mm.		Ft.	in.
Total length	1855	=	6	1
Height of body	540	=	1	9¼
Length of head	407	=	1	4
Length of caudal	280	=	0	11
Base of dorsal fin	610	=	2	0
Base of anal fin	635	=	2	1

As remarked by Day,[5] "The habits of *Luvarus* are scarcely known: the young have been captured near the surface at sea. Its intestines would seem to point to its being a vegetable feeder, which probably does not live at any great depths in the ocean."

Mr. Laycock's observation may throw a little light on the subject. The fish is evidently of pelagic habit, and when stranded was apparently following up the stream of pelagic life which engaged the attention of the Basking Shark, taken within a few miles of the same locality and at the same time. As I have described (p. 261), this pelagic flux consisted largely of *Munida*

[5] Day—Fishes Gt. Britain and Ireland, i., 1880–4, p. 122.

subrugosa; and the characterising of Whale-food as "small shrimps" by the Fisheries Inspector in connection with *Luvarus*, leaves little doubt as to the nature of the food of this fish.

Day's opinion as to its being a vegetable feeder was deduced only from an inspection of the intestines; the entire absence of teeth in the adult is another factor in favour of its habit as a feeder on pelagic organisms.

The author last writing on *Luvarus* is G. Kolombatovic'; but not having access to his paper,[6] I am unaware if he deals with the skeleton.

Since writing the paper I have seen the account and picture of this fish published in the *Scientific American*,[7] a notice of which, by Dr. D. S. Jordan, reads as follows[8]:—"In the *Scientific American* for December 21, Mr. C. F. Holder publishes a photograph of *Luvarus imperialis*, a large and rare fish of the Mediterranean, lately taken at Avalon on Santa Catalina Island, off the coast of California. There is no question as to the identity of the species with the genus Luvarus, and no specific difference appears in Mr. Holder's photograph, a copy of which the writer has seen."

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[6] Kolombatovic —Druge. Zool. Vijest. iz Dalmaciji, 1900.

[7] Holder—*Scientific American*, lxxxv., 1901, p. 415.

[8] Jordan—*American Naturalist*, lxxxvi., 1902, p. 336.